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FCC FILINGS IN SUPPORT OF NORTHPOINT

(Contained in FCC Comments and Reply Comments -- ET Docket No. 98-206)

Broadcasters:

National Association of Broadcasters (NAB)
National Association of Black Owned Broadcasters (NABOB)
Local Broadcast Station Owners (130 stations):
- Joint Comments:
  - Benedek Broadcasting Corporation
  - Corridor Television, LLP
  - Eagle III Broadcasting, LLC
  - Granite Broadcasting Corporation
  - Lin Television Corporation
- Separate Comments:
  - Gray Communications Systems
  - Paxson Communications Corporation
  - Second Generation of Iowa

Consumer and Minority Advocacy Groups:

Consumers Union, *et. al.*
- Center for Media Education
- Consumer Federation of America
- Consumers Union
- Leadership Conference on Civil Rights
- League of United Latin American Citizens
- Media Access Project

Minority Media and Telecommunications Council (MMTC)
National Indian Telecommunications Institute (NITI)

Others:

Tom Hazlett (Economist)
*Virtual Geosatellite, LLC (NGSO)

*Comments support spectrum sharing

FCC Should Grant Licenses Promptly

"CU, *et al.* urge the Commission to grant the license and waiver applications of Northpoint and its Broadwave Affiliates. . . . The public interest will be best served by prompt approval [of] Northpoint's applications to provide a terrestrially-based Multichannel Video Programming Distribution ("MVPD") service that will bring instant competition and rapid deployment of broadband services to the entire country, including unserved and underserved rural and urban areas. The authorization of a new Multichannel Video and Data Distribution Service ("MVDDS") and possible auctions would delay and possibly undermine the expansion of competition to incumbent cable and satellite companies." (CU, *et al.* Reply Comments, pp. 2-3)

"NAB supports [Northpoint's] applications and request for a waiver of the rules. Prompt initiation of Northpoint's plans could: 1) promote much needed competition in the MVPD marketplace. . .; and 2) facilitate local into local carriage of all local television stations." (NAB Reply Comments, p. 2)

"For the reasons set forth above, the Commission should not proceed with commencement of a new MVDDS service and should terminate its rulemaking proceeding." (NAB Reply Comments, p. 7)

"A one-year delay – assuming lightning fast allocation rules and auction implementation – could (conservatively estimated) result in $2 billion in lost consumer surplus in cable television service, and another $250 million lost in reduced competition for high-speed Internet access. A three-year lag would likely exceed $6 billion in lost (aggregate) consumer surplus." (Hazlett Affidavit, p. 21)

"The short-run interest of consumers is to have service commence quickly. The long-run interest of consumers is to have entrepreneurship rewarded rather than taxed. From either perspective, the public's interest lies in having the FCC grant Northpoint's January 1999 request for permission to commence service without delay." (Hazlett Affidavit, p. 22)

Call for Auctions Should be Rejected

"[A]uctions will only serve to delay and possibly even destroy, competition and innovation." (CU, *et al.* Reply Comments, p. 4)

"As Northpoint correctly observes, auctions could 'postpone for many more years the delivery of local broadcast signals to rural users, and it would delay the emergence of new competitive alternatives to cable.'" (NAB Reply Comments, p. 3)

"There are several reasons why the Commission should decline to hold auctions here. The first is a matter of equity. . . . The second is a matter of law." (CU, *et al.* Reply Comments, pp. 6-7)

"Moreover, Section 309(j)(3) of the Communications Act obligates the Commission to avoid mutual exclusivity and auctions when there are public interest reasons for doing so. What the incumbent MVPDs do not and cannot, dispute is that significant public interest benefits will flow from the grant of the Northpoint applications." (CU, *et al.* Reply Comments, p. 5)

Only Northpoint Can Deploy Technology

"Northpoint – and only Northpoint – has developed a technology for video programming delivery that may quickly be implemented across the country to provide competition to cable and direct broadcast satellite (DBS)." (Joint Broadcasters Comments, p. 2)

"Northpoint is the only terrestrial applicant that is ready, willing and able to provide a competitive local broadband video and data service." (MMTC Comments, p. 2)

"Northpoint would be the only terrestrial provider in the 12.2-12.7 GHz band because only Northpoint has invested the creativity and resources to develop the technology to use this particular spectrum for terrestrial video delivery." (Joint Broadcasters Comments, p. 7)

"If other terrestrial competitors eventually develop, then they can make the same applications and the same showings of technical compatibility as Northpoint, and the Commission may consider them on a case-by-case basis." (Joint Broadcasters Comments, p. 7)

Northpoint Would Bring Price Competition, Promote Local TV

"Because Northpoint's video and data services are less expensive, the effect on prices in American communities will be dramatic." (MMTC Comments, p. 6)

"Northpoint plans to deliver 96 channels of video programming, including all local broadcast signals, for fees that are 10%-15% below existing cable television rates. If we assume that Northpoint's entry succeeds in pushing cable rates down 5% nationally, the annual savings for U.S. households exceeds $2 billion." (Hazlett Affidavit, p. 17)

"If its applications are approved, Northpoint could provide instant MVPD competition to all 210 DMAs in the United States. Because its services are almost certain to be comparable with cable and DBS yet far less expensive, competitors will be pressured to lower their prices. The final result: more choice, better service and lower cost for all Americans." (CU, *et al.* Reply Comments, pp. 14-15)

"Joint Broadcasters enthusiastically support the introduction of another competitor and another carrier of their signals in this highly concentrated market to help benefit the public with price, service, and innovation competition." (Joint Broadcasters Comments, p. 2)

"Paxson notes that Northpoint and its local Broadwave affiliates are committed to carrying the analog and digital signals of local television stations to the same extent required of cable systems by the FCC and Paxson believes that the final rules adopted by the FCC will mandate full digital must carry for all local stations. This will certainly provide additional competition in the multi-channel video programming market, will assist local television station in their DTV transition efforts and strengthen the role of free, over-the-air television broadcasting." (Paxson Reply Comments, pp. 1-2)

"Gray believes that it is imperative that the Commission facilitate the introduction of another competitor and another carrier of local television signals in this highly concentrated market to help benefit the public with price, service, innovation and competition as quickly as possible." (Gray Reply Comments, p. 2)

Northpoint Serves Broad Range of Public Interests

"[I]t is difficult for us to imagine a potential licensee that could make a stronger public interest showing warranting its license. Northpoint brings to the table the prospect of immediate competition, an immediate increase of minority ownership in the MVPD marketplace, and immediate deployment of advanced services to rural and underserved areas. We ask the Commission to reject the incumbents' claims that the public interest would best be served by embarking on a lengthy new process that may not lead to more MVPD competition, and instead grant Northpoint's license without delay." (CU, *et al.* Reply Comments, p. 3)

"[No commenters in this docket] refute the fact that Northpoint's proposed service would result in numerous public interest benefits, including: Increased competition in the market for multiple video program distribution and other broadband services; lower priced MVPD and broadband services for all Americans; greater and more rapid deployment of broadband services, especially to unserved and underserved communities; and a significant increase in the number of minority and female owners and employees in the media industry." (NABOB Reply Comments, p. 2)

Northpoint Promotes Minority and Female Media Industry Ownership

"The Northpoint application provides an opportunity for the Commission to promote minority ownership and employment and its benefits without reliance on disfavored regulatory mechanisms." (CU, *et al.* Reply Comments, p. 20)

"Importantly, from MMTC's perspective, grant of Northpoint's applications will give an instant and important boost to minority ownership and employment in the media industry at a time when regulatory policies to promote such ownership and employment are out of favor." (MMTC Comments, p. 2)

"No participant to this proceeding denies the fact that, should Northpoint obtain the approval it seeks from the Commission, the landscape of minority media ownership in this country would be altered dramatically. Not only are the majority of Northpoint's Broadwave affiliates minority and female owned, they are overwhelmingly so." (NABOB Reply Comments, p. 5)

Northpoint Promotes Specific Needs of Minority Consumers

"The lower cost service that it [Northpoint] proposes will increase broadband access for minorities and rural residents, and will increase the diversity of voices available to all citizens." (MMTC Comments, p. 2)

"Commission approval of the Broadwave applications is the only realistic course of action that will enable tribal communities and other low-income, high-cost communities to receive digital audio, video and data services in the near future." (NITI Comments, p. 6)

"Northpoint's low-cost digital wireless system would offer many Native Americans their first opportunity for broadband access to the Internet." (NITI Comments, p. 6)

"Minority communities are often the last to have access to affordable broadband services, but Northpoint will provide such an option." (MMTC Comments, p. 4)

Northpoint Will Bring Broadband to Many

"Should the Commission thwart Northpoint's attempts to deploy broadband services by instituting auctions for terrestrial MVPD licenses, it would run contrary to Section 706's mandate that the Commission 'utiliz[e]...regulatory forbearance, measures that promote competition in the local telecommunications market or other regulating methods that remove barriers to infrastructure investment' to encourage broadband deployment." (CU, *et al.* Reply Comments, p. 17)

"Entry by Northpoint could considerably speed the "race for bandwidth." In creating a first, second or third broadband high-speed access option for residential customers, millions of additional Internet users could avail themselves of broadband services." (Hazlett Affidavit, p. 19)

Opponents' Motivation is Not in the Public Interest

"The Commission must take the opposition to Northpoint's applications and the subsequent support for auctions for what it really is – an attempt by incumbent MVPDs to misuse governmental processes to delay and eventually destroy a low cost, innovative competitive broadband MVPD service. Once the victims of cable operators' attempts to block their service, the two DBS providers now employ similar tactics in seeking governmental protection for their duopoly. The Commission should not allow a legitimate license distribution process for new spectrum – auctions – to be misused for anticompetitive purposes in this secondary licensing proceeding." (CU, *et al.* Reply Comments, p. 4)

"The majority of commenters supporting auctions in this proceeding have done so not with the public interest in mind, but to protect themselves from competition. The Commission has the authority to declare that auctions for MVDDS licenses are not in the public interest and that grant of Northpoint's applications is in the public interest. It should do so without further delay." (NABOB Reply Comments, p. 7)

"Once the victimized new kid on the block, the DBS industry has adopted the mantle of powerful incumbent and is seeking to use the Commission to forestall a less expensive, serious competitor. The Commission should just say 'no' to this anticompetitive effort and permit Northpoint to commence service expeditiously." (MMTC Comments, p. 3)

"While cable and DBS basically built their industries by retransmitting broadcast signals . . . both industries have fought tooth and nail against must carry, carry one carry all, retransmission consent, program exclusivity rules and virtually every other regulatory provision Congress or the FCC has considered to preserve the very free over-the-air broadcast system . . . . Now, like a breath of fresh air, comes Northpoint Technology, Ltd., and its local Broadwave affiliates (collectively, "Northpoint"). Northpoint too wants to retransmit broadcast signals. But it also appears willing voluntarily to undertake the full signal carriage and program exclusivity protection that its larger competitors have so steadfastly resisted." (NAB Reply Comments, p. 2)

Support for Satellite-Terrestrial Sharing in 12 GHz Band

"Virtual Geo adheres to its belief in the compatibility of NGSO FSS systems and Northpoint-type MVDDS stations. It urges the Commission to adopt rules that facilitate the introduction of both types of services into the 12.2-12.7 GHz band in a manner that does not cause undue constraint to NGSO FSS systems and that take into account the constraints that such systems have accepted in order to successfully share the band with geostationary satellite systems." (Virtual Geosatellite Comments, p. 4)

- Note: Virtual Geo is one of eight applicants to operate a non-geostationary fixed-satellite service (NGSO FSS) in the same 12 GHz spectrum band in which Northpoint would operate its terrestrial service and limited its comments to spectrum sharing issue.

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POWER CONTROL

US006208834B1

(12) **United States Patent**
Tawil et al.

(10) **Patent No.:** **US 6,208,834 B1**
(45) **Date of Patent:** **Mar. 27, 2001**

(54) **APPARATUS AND METHOD FOR FACILITATING TERRESTRIAL TRANSMISSIONS AT FREQUENCIES ALSO USED FOR SATELLITE TRANSMISSIONS TO A COMMON GEOGRAPHIC AREA**

(75) Inventors: **Saleem Tawil; Carmen Tawil**, both of Austin, TX (US)

(73) Assignee: **Northpoint Technology, Ltd.**, Portsmouth, NH (US)

(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **09/001,766**

(22) Filed: **Dec. 31, 1997**

1997

Related U.S. Application Data

(63) Continuation-in-part of application No. 08/731,244, filed on Oct. 11, 1996, now Pat. No. 5,761,605.

(51) **Int. Cl.**^{7} **H04H 1/00**; H04B 7/185

(52) **U.S. Cl.** **455/3.2**; 455/13.3

(58) **Field of Search** 455/3.2, 13.3, 455/427, 430, 12.1, 63, 272, 188.1, 179.1, 562; 348/6, 12, 13; 343/879, 893, 878, 840

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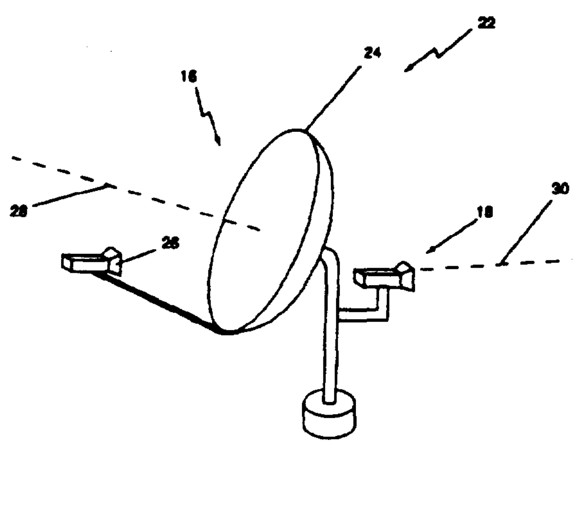
Primary Examiner—Nguyen Vo
(74) *Attorney, Agent, or Firm*—Russell D. Culbertson; Shaffer & Culbertson, LLP

(57) **ABSTRACT**

A satellite receiving antenna (16) at a user location (14) receives satellite signals at a first frequency from a satellite (12). The satellite signals travel along a satellite signal route (42) within a look angle about the centerline (28) of the antenna (16). A terrestrial transmitter (20) transmits signals at the first frequency along a wireless transmission route (40) from the transmitter to the user location (14). The terrestrial transmitter (20) is located with respect to the user location (14) so that the wireless transmission route (40) is at a relatively large angle to the centerline (28) of the first antenna (16). The angle of the wireless transmission route (40) to the satellite antenna centerline (28) is large enough so that the terrestrial signals present at the location (14) result in terrestrial input signals from the antenna (16) which are less than an interference level with respect to satellite input signals produced by the antenna. Thus, the terrestrial signals do not interfere with the satellite signals even though they are transmitted at a common frequency.

20 Claims, 3 Drawing Sheets



Claims start Column # 13

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Figure 1

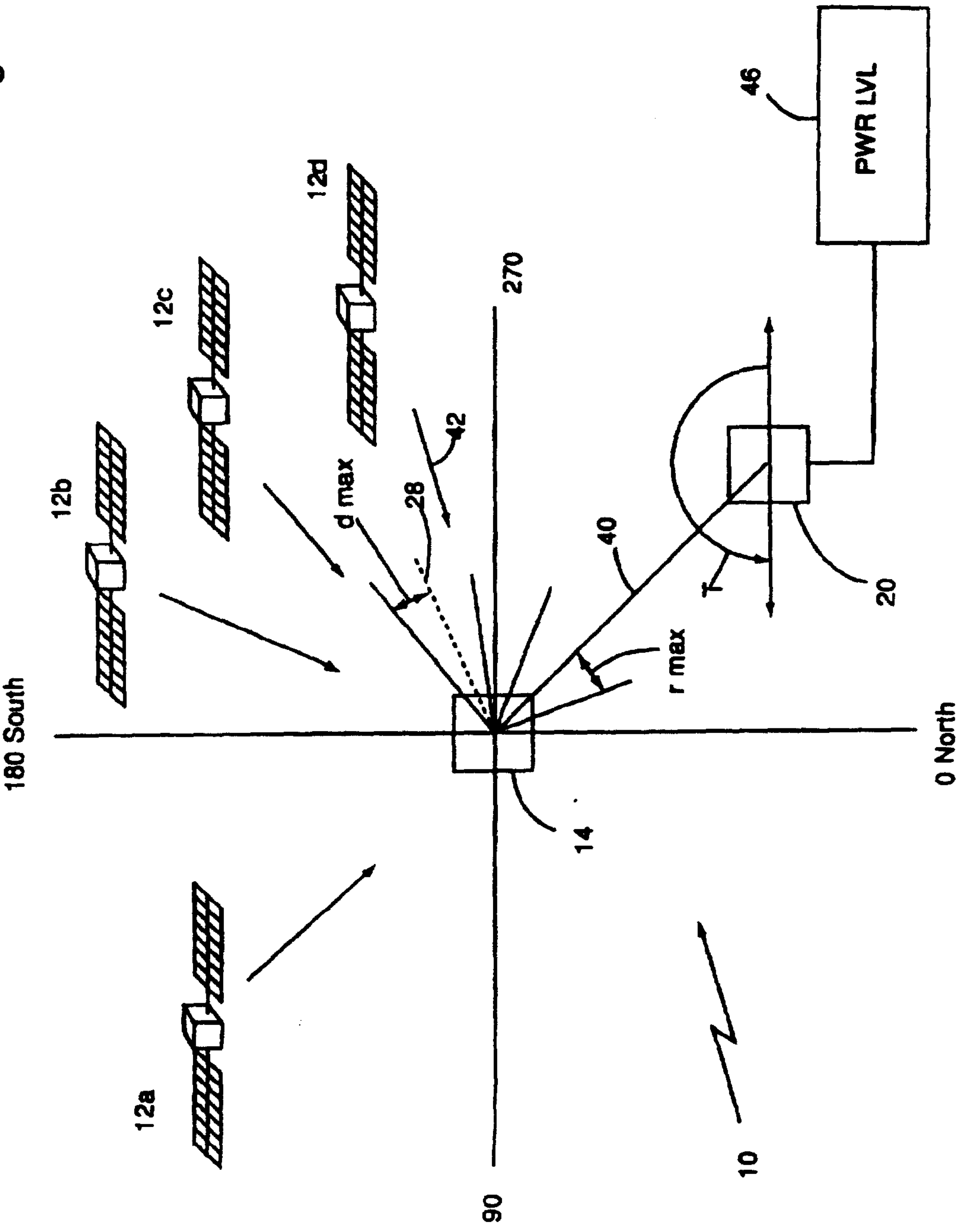

12a
12b
12c
12d
180 South
0 North
90
270
14
10
20
28
40
42
46
PWR LVL
d max
r max

Figure 2

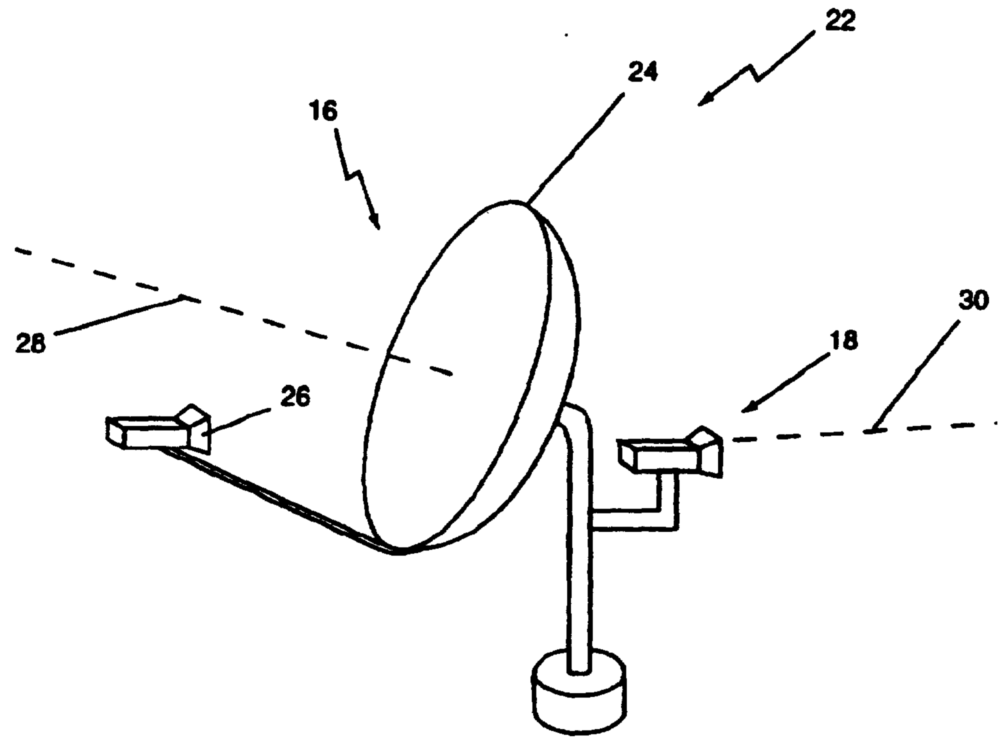
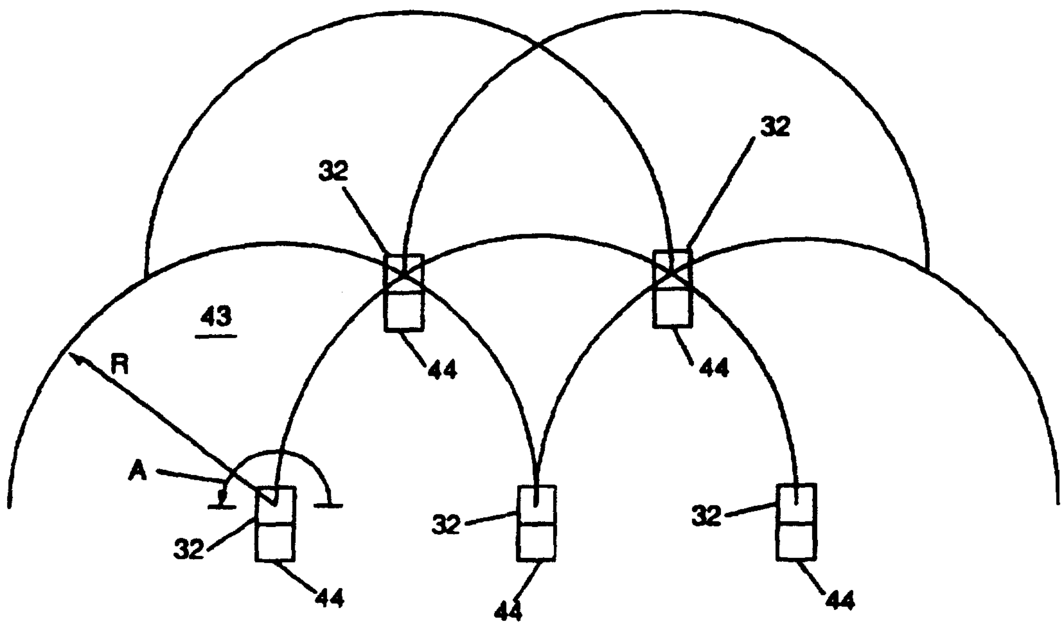


Figure 3



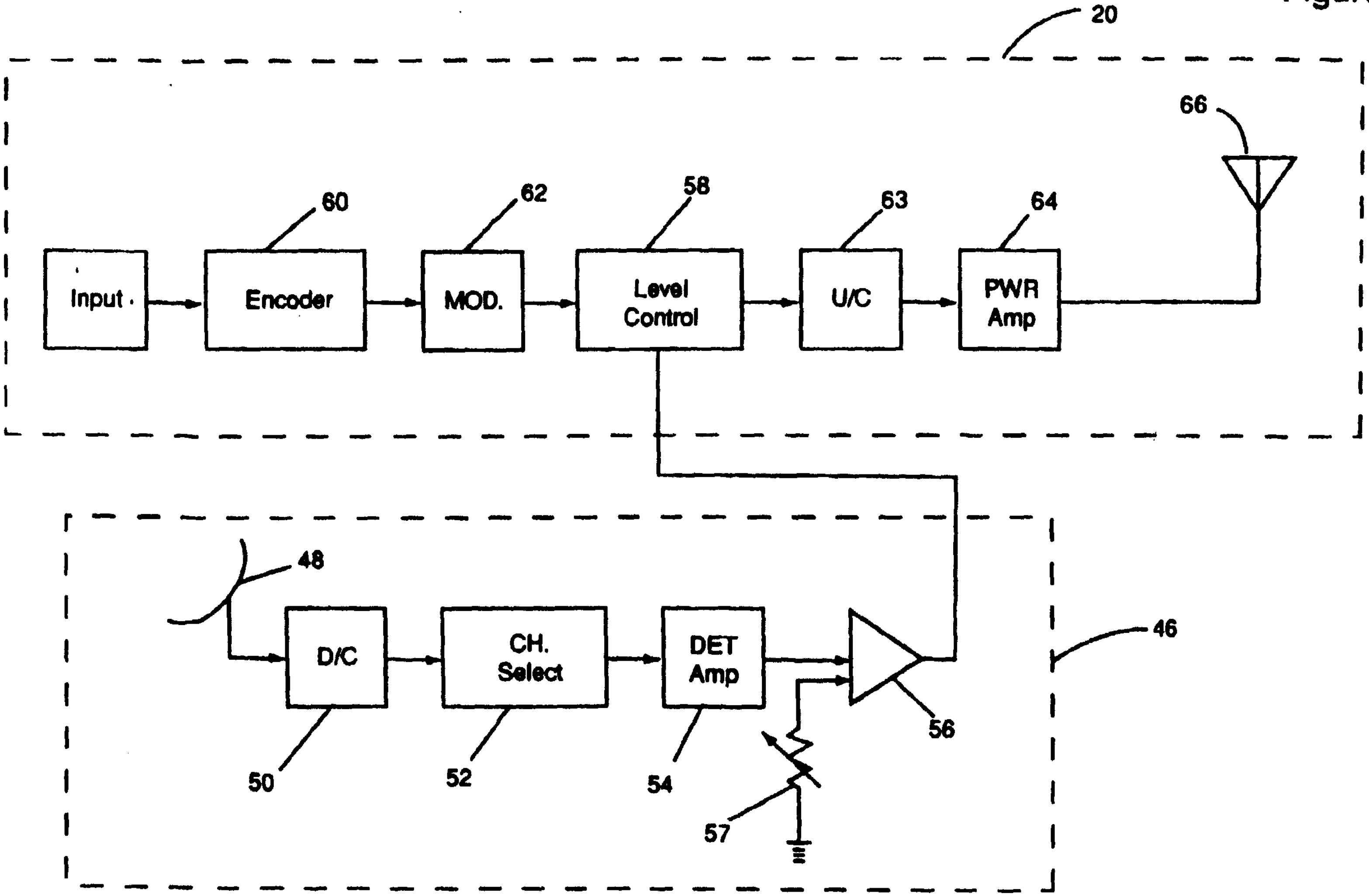

20
66
60
62
58
63
64
Input
Encoder
MOD.
Level Control
U/C
PWR Amp
48
46
D/C
CH. Select
DET Amp
50
52
54
56
57

Figure 4

APPARATUS AND METHOD FOR FACILITATING TERRESTRIAL TRANSMISSIONS AT FREQUENCIES ALSO USED FOR SATELLITE TRANSMISSIONS TO A COMMON GEOGRAPHIC AREA

This application is a continuation-in-part of application Ser. No. 08/731,244 filed Oct. 11, 1996, now U.S. Pat. No. 5,761,605.

BACKGROUND OF THE INVENTION

This invention relates to apparatus and methods for broadcasting and receiving data, including digital television signals, voice signals, and other data. More particularly, this invention relates to an apparatus and method for providing terrestrial transmissions simultaneously along with direct broadcast satellite transmissions on a common frequency and for setting the transmission power level for the terrestrial transmissions.

Currently, television signals may be received from a satellite in geosynchronous orbit about the earth. The television signals are transmitted from a terrestrial transmitter to the satellite, perhaps communicated between different satellites, and then retransmitted from a satellite so that the signals can be received by terrestrial receivers within a certain geographic receiving area within a line of sight of the satellite. In addition to television signals, other types of data may also be transmitted to consumers through satellites in either geosynchronous or non-geosynchronous orbit.

Direct broadcast satellite service (DBS) refers to satellite transmission of television signals and other data directly for use by individual households or subscribers having the proper signal receiving equipment. The U.S. Federal Communications Commission has dedicated the electromagnetic spectrum from 12.2 gigahertz to 12.7 gigahertz for DBS broadcasting. Numerous signal carriers are located within the DBS spectrum, each carrier carrying several individual television channels. Depending upon the compression technology applied to these signals, literally hundreds of separate channels may be available through DBS. A great benefit of the DBS system as opposed to prior satellite systems is that only a small dish-type antenna is required to receive the DBS signals and the alignment of the receiving dish is not as critical as earlier satellite broadcast systems. Also, the DBS system will provide high quality reception at any point in the geographic receiving area of a satellite without the expense of land transmission lines such as those required for cable television.

Current regulations require that DBS satellites be separated from each other by at least nine (9) degrees in a geosynchronous arc. The receiving antenna for DBS signals must, therefore, be limited to receiving signals in a directional range measuring plus or minus nine (9) degrees from a centerline of the antenna. Receiving signals in a range wider than the satellite spacing would cause interference by signals transmitted by different satellites on the same frequency. The limited directional reception range of the DBS receiving antenna is the result of the gain provided by the antenna being asymmetrical about the antenna structure. DBS signals reaching the DBS receiving antenna at angles outside of the directional range of the antenna receive insufficient gain to interfere with the desired DBS signals received within the antenna directional range.

U.S. Pat. No. 5,483,663 is directed to a system having a receiver arrangement in which DBS and terrestrial signals are received within similar frequency bands. The system shown in the 5,483,663 Patent may be implemented with a multiple antenna arrangement, or with a single, moveable antenna. In the multiple antenna arrangement, two separate antennas direct the received signals to a common propagation path for processing as if they were received by a single antenna and transmitted from a single location. In the single antenna arrangement, the antenna is movable between a position to receive DBS signals and another position to receive terrestrial signals.

The advantage of the system shown in U.S. Pat. No. 5,483,663 is that local originating signals, whether carrying data for television or other data, may be received simultaneously with DBS signals, and processed with the same or similar equipment as that used to process the DBS signals. The local originating signals may carry local television programming which may be received along with the national or regional DBS television programming.

SUMMARY OF THE INVENTION

It is an object of the invention to provide terrestrially transmitted signals simultaneously with satellite transmitted signals at the same frequency. The invention includes an apparatus and method for use in transmitting terrestrial signals simultaneously with satellite signals transmitted at a common frequency.

The object of the invention is accomplished by transmitting terrestrial signals in a manner which ensures that they do not interfere with satellite signals transmitted at the same frequency. Embodiments of the invention may take advantage of receiving antennae having a limited directional reception range or look angle and may include transmitting the terrestrial signals in a different range of directions than those in which the satellite signals are transmitted. The power level at which the terrestrial signals are transmitted and the directional nature of the satellite receiving antennae ensure that the satellite transmitted signals can be discriminated from the terrestrially transmitted signals. Although the terrestrial signal transmission power is limited to a non-interfering transmission power level, the terrestrial transmission is still strong enough to produce a usable signal at a distant location.

Several different signals will be discussed in this disclosure. The term "satellite signals" refers to signals transmitted directly from a satellite, whereas the term "terrestrial signals" refers to signals transmitted directly from a terrestrial transmitter. "Satellite input signals" refers to signals resulting from satellite signals which have been picked up by an antenna and subjected to gain provided by the antenna. Finally, "terrestrial input signals" refers to signals resulting from terrestrial signals which have been picked up by an antenna and subjected to gain provided by the antenna.

The invention is employed in the situation in which satellite signals are transmitted at a satellite transmission frequency to a terrestrial location. The satellite signals travel along a satellite signal route from the satellite to the terrestrial location and to a satellite receiving antenna at the location for receiving the satellite signals. In some embodiments of the invention, the satellite receiving antenna is omni-directional, that is, provides generally the same gain regardless of the direction from which the signals reach the antenna. In other forms of the invention, the satellite receiving antenna has a directional reception characteristic in which the gain provided by the antenna reaches a peak along an antenna centerline and generally decreases as the angle from the centerline increases.

The omni-directional satellite receiving antenna need not be oriented in a particular direction to receive signals from a satellite. However, in order to receive satellite signals with the directional satellite receiving antenna, the antenna must be aligned in a satellite reception position. In this satellite reception position, the satellite signal route lies close enough to the antenna centerline that the signals receive sufficient gain from the antenna structure to produce satellite input signals which are at least at a usable input signal level. This minimum usable input signal level represents the minimum input signal level at which the receiving or signal processing equipment can extract the desired data.

According to the invention, the terrestrial signals are transmitted at the same frequency as the satellite signals. The terrestrial signals are transmitted along a wireless route from the terrestrial transmitter to a user location which may have a satellite receiving antenna. The invention avoids interference between the terrestrial and satellite signals by ensuring that the power level of the terrestrial input signals at the satellite receiving antenna is below an interference level with respect to the satellite input signals at the satellite receiving antenna. The interference level is an input signal power level which is so close in power to the satellite input signal power level that the satellite input signals cannot be discriminated or distinguished. Terrestrial input signals below the interference level do not prevent the receiving or signal processing equipment associated with the satellite receiving antenna from distinguishing and extracting data from the satellite input signals. Also according to the invention, although the terrestrial signals are transmitted so that they do not interfere with the satellite signals, the terrestrial signals present at the user location must be strong enough so that they may be received by an appropriately aligned terrestrial receiving antenna at the location and distinguished from satellite input signals at the terrestrial receiving antenna. That is, the terrestrial signals present at the location must be at least at a minimum usable terrestrial signal level.

Where the satellite receiving antenna is omni-directional, both the satellite signals and the terrestrial signals picked up by the antenna receive substantially the same gain. Thus for omni-directional satellite receiving antennae, the terrestrial transmission power level must be controlled so that the terrestrial signals present at the user location have a sufficiently lower power level than the satellite signals present at the user location.

Where the satellite receiving antenna at the user location is a directional antenna, the invention may take advantage of the directional characteristic of the antenna and may transmit terrestrial signals at a high enough power level while still producing a terrestrial input signal at the satellite receiving antenna which is below the interference level. In the case of the directional satellite receiving antenna, the antenna is oriented in the satellite reception position at the user location. The terrestrial transmitter is located with respect to the user location such that the wireless transmission route from the terrestrial transmitter to the user location is at a relatively large angle from the satellite receiving antenna centerline. At this relatively large angle, the terrestrial signals receive much less gain than the satellite signals. Thus, the terrestrial signal power level at the user location may be the same as or even higher than the satellite signal level and, due to the different gain applied to the signals by the antenna structure, still result in a terrestrial input signal having a power level below the interference level with respect to the satellite input signal level.

In some applications of the invention, depending upon the direction at which a directional satellite receiving antenna must be directed to receive satellite signals, the terrestrial transmissions may be limited to a certain azimuth range. This terrestrial transmission azimuth range is limited so that it does not include any directions that are within the satellite reception look angle of a directional satellite receiving antenna aligned to receive signals from a particular satellite. In order to cover a large geographic service area for terrestrial signal reception while maintaining the terrestrial transmission power at a non-interfering level, a plurality of terrestrial transmitters may be spaced apart over the area. In this case the effective transmission areas of the different transmitters combine to ensure the terrestrial signals may be received clearly at each location within the desired geographic service area.

The satellite transmissions and terrestrial transmissions may contain or carry any type of data including television, internet communications, voice, video, or any other type of data. Although the invention is not limited to any particular transmission frequencies, the invention is particularly well adapted for transmission frequencies above one thousand (1000) megahertz. Also, although the invention is not limited for use with a particular transmission modulation technique, modulation techniques such as phase modulation and spectrum spreading (frequency hopping) are currently preferred.

These and other objects, advantages, and features of the invention will be apparent from the following description of the preferred embodiments, considered along with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic representation showing the positions of a plurality of satellites in relation to a single terrestrial transmitter and a receiver or user location.

FIG. 2 is a somewhat schematic representation of a receiving antenna structure for receiving satellite and terrestrial transmitted signals at a common frequency.

FIG. 3 is a schematic representation of the spacing for a number of terrestrial transmitters required to allow reception over a large geographic area.

FIG. 4 is a schematic representation of a terrestrial transmitter and terrestrial transmission power control arrangement embodying the principles of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An apparatus according to the invention for providing terrestrially transmitted signals simultaneously on the same frequency used to transmit satellite signals is illustrated in FIG. 1. As shown in FIG. 1, there may be one or more satellites in orbit about the earth. FIG. 1 shows four satellites **12***a*, **12***b*, **12***c*, and **12***d* spaced apart at four separate directions from a user location **14**. Satellite receiving antenna **16** and terrestrial receiving antenna **18**, which will be discussed in detail with reference to FIG. 2, may be located at the user location **14**.

Each of these satellites **12***a–d* is positioned in geosynchronous orbit about the center of the earth, and is positioned at a certain longitude and latitude above the earth's surface. In geosynchronous orbit, each satellite remains at a fixed location with respect to the earth's surface, and thus, with respect to the user location **14**. As is known by those skilled in the art, a directional receiving antenna may be directed at a certain elevation and direction or azimuth toward a desired satellite location for receiving signals from the particular satellite. Of course the satellite signals may be transmitted from satellites which are not in geosynchronous orbit. In this non-geosynchronous orbit case, the directional satellite receiving antenna can receive satellite signals only as the particular satellite passes through the directional reception range or look angle of the satellite receiving antenna, or the antenna must be moved to track the satellite.

Currently, all direct broadcast satellites within the line of sight of North America are positioned at longitudes and latitudes requiring a directional receiving antenna to face in a southerly direction from North America to receive signals. Although FIG. 1 shows four satellites **12a–d** for purposes of describing the invention, more or fewer satellites may be spaced apart within a line of sight of a certain geographical area. Regardless of the number of satellites, the directional satellite receiving antenna must be directed at a particular azimuth and elevation to receive signals from a particular satellite. The term "azimuth" refers to the direction with respect to a reference direction such as due north, commonly zero degrees. "Elevation" refers to the angle of the antenna centerline above horizontal. In contrast to directional receiving antennae, omni-directional antennae need not be oriented in any particular direction in order to receive signals. Thus an omni-directional antenna at the user location **14** would receive signals equally well from each of the satellites **12a–d**.

DBS satellites all transmit different signals in the same frequency band. The U.S. Federal Communications Commission has set aside the electromagnetic spectrum from 12.2 gigahertz to 12.7 gigahertz for DBS broadcasting. In order to ensure no interference from signals between two adjacent satellites transmitting at the same frequency, two conditions must be met. First, the satellite receiving antenna must be a directional antenna and limited to receive signals at the DBS signal strength only within a certain reception range about the centerline of the antenna. Secondly, the satellites must be spaced apart so that a receiving antenna may be positioned with only a single satellite transmitting in the directional reception range or look angle of the antenna.

According to current regulations, individual DBS satellites must be separated at least nine (9) degrees in the geosynchronous arc. Thus, each DBS receiving antenna must have a directional reception range, look angle, or aperture of plus or minus nine (9) degrees or less as measured from a centerline of the antenna. Although current regulations require a spacing of no less than nine (9) degrees separation, the invention is not limited to use in situations in which the satellites have this degree of separation or in which the satellites operate in the current DBS frequencies.

FIG. 1 also shows a terrestrial transmitter **20** capable of transmitting in one or more frequencies identical to a frequency transmitted by one of the DBS satellites. The terrestrial transmitter **20** transmits directionally within a certain transmission range or azimuth range T. The transmission range T shown in FIG. 1 is 180 degrees, although the range may be more or less than this number. In some situations, the transmission range may not be limited but may encompass the entire 360 degrees around the transmitter location.

A combined receiving antenna structure **22** which may be at the user location **14** in FIG. 1 is illustrated in FIG. 2. The satellite receiving antenna **16** is designed to receive direct broadcast satellite signals and preferably includes a collecting dish **24** and a feed-horn assembly **26** for receiving the signals reflected and concentrated by the dish. Those skilled in the art will readily appreciate that the feed-horn assembly **26** includes a probe and low noise block converter, which are not shown in FIG. 2, for picking up signals directed to the antenna. The received signals, which are defined herein as "input signals," are directed from the antenna to receiving or signal processing equipment, also not shown, for extracting information or data. This signal processing equipment is well known in the art and does not form a part of this invention. Also, those skilled in the art will appreciate that numerous types of assemblies may be used alternatively to the feed-horn assembly **26** for collecting signals reflected by the dish **24**. Furthermore, many other types of antennae may be used for receiving the satellite signals.

The satellite receiving antenna **16** is a directional antenna and thus has the characteristic that the signal gain produced by the antenna is highly dependent upon the direction at which the signals reach the antenna. The antenna **16** produces a maximum gain for signals travelling to the structure along an antenna centerline **28**. For signals travelling to the antenna structure **16** at an angle to the centerline **28**, the antenna provides less gain. For the dish-type antenna **16** shown in FIG. 2, the antenna gain decreases as the angle to the centerline **28** increases up to a certain angle on either side of the centerline. At angles outside of this certain angle, the gain may remain fairly constant. It will be understood that the angle from the centerline **28** may be in the horizontal direction, vertical direction, or both.

As the antenna gain decreases with the increased angle from the centerline **28**, an angle is reached at which the antenna gain is insufficient to develop a usable satellite input signal from the antenna **16** for a particular satellite transmission. The maximum reception angle at which the antenna **16** will develop a usable signal is shown as d max in FIG. 1. The cone-shaped area defined by the angle d max about the centerline **28** is commonly referred to as the "look angle" or aperture of the antenna. Satellite signals at the designated power level propagating to the antenna **16** at an angle greater than d max to the antenna centerline **28** result in input signals from the antenna less than the minimum usable input signal level. Signals below the minimum usable input signal level cannot be distinguished from background or noise produced by the antenna, and the signal processing equipment which receives the input signals cannot extract data from signals at these low signal levels. The minimum usable input signal level is determined by many factors including the bandwidth of the transmissions, the antenna structure, and the signal processing equipment which receives the signals developed by the antenna structure.

Referring to FIGS. 1 and 2, the satellite receiving antenna **16** which may be at location **14** is in a satellite reception position and is directed to receive signals from one of the satellites, satellite **12d** for example. The azimuth and elevation at which the first antenna **16** must be directed for optimally receiving signals from satellite **12d** may be, for example, 247.3 degrees and 25.7 degrees, respectively.

In the orientation shown in FIG. 1, the satellite receiving antenna **16** at location **14** cannot receive signals from the terrestrial transmitter **20** in the presence of satellite signals at the same frequency. Two factors combine to prevent interference between the satellite and terrestrial signals. First, signals transmitted from the terrestrial transmitter **20** travel along a wireless transmission route **40** to the location **14** which lies outside of the look angle of the satellite receiving antenna **16**. Thus, the terrestrial signals receive relatively low gain from the satellite receiving antenna **16** as compared to the satellite signals travelling along a satellite signal route **42** within the look angle of the antenna. Second, the terrestrial transmission power level is controlled according to the invention such that terrestrial signals at the location 14, with the low gain provided by the antenna 16 for signals travelling along wireless transmission route 40, result in terrestrial input signals from the antenna 16 which are below the interference level with respect to the satellite input signals from the antenna. Thus, even though the terrestrial signals may actually be picked up by the antenna 16 and produce terrestrial input signals from the antenna, the satellite input signals are in comparison strong enough for the signal processing equipment associated with the antenna to discriminate between the satellite and terrestrial input signals. The interference level will depend on several factors including primarily the signal processing equipment and, with present technology, may be in the range of 3 dB to 5 dB below the level of the satellite input signals.

Although the direction of the terrestrial transmissions along wireless route 40 and terrestrial signal power level combine to prevent the terrestrial signals from interfering with the satellite signals at the same frequency, the power level of the terrestrial transmissions is still sufficient to produce a usable signal at the location 14. In order to receive terrestrial signals at the location, a terrestrial receiving antenna such as the antenna 18 shown in FIG. 2 is required. The terrestrial receiving antenna 18 has a directional gain characteristic similar to the satellite receiving antenna 16 to ensure that the terrestrial signals produce an input which may be discriminated from the input produced by the satellite signals at the terrestrial antenna. For example, the terrestrial receiving antenna 18 at location 14 could have its centerline 30 aligned directly with the wireless transmission route 40 from the terrestrial transmitter 20. The directional reception range or look angle from the centerline of the antenna 18 is shown as r max in FIG. 1. At this orientation, the satellite signals are well outside the look angle of the terrestrial receiving antenna 18 and receive much lower gain as compared to the terrestrial signals. The terrestrial signals at that location 14 are strong enough that, with the help of the gain provided by the terrestrial receiving antenna 18, they result in terrestrial input signals that may be discriminated from any input signals at the terrestrial receiving antenna resulting from the satellite signals. With present technology the terrestrial input signals from the terrestrial receiving antenna 18 may be 3 dB to 5 dB or more above the power level of the satellite input signals from the terrestrial receiving antenna in order for the terrestrial input signals to be discriminated. Thus, the terrestrial transmission apparatus and method according to the invention allows satellite and terrestrial signals carrying entirely different information or data to be received and used simultaneously at user location 14.

The ability to transmit terrestrial signals at the same frequency as satellite signals without interference between the signals presents an opportunity for terrestrial reuse of spectrum previously reserved exclusively for satellite transmissions. Furthermore, since the terrestrial transmitter according to the invention has a limited effective transmission range, the spectrum reused for the terrestrial transmissions may also be reused for terrestrial transmissions in many different geographic areas.

It will be understood that the terrestrial receiving antenna 18 at the location 14 or any other user location, is not an element of the present invention. The terrestrial receiving antenna 18 is disclosed and discussed herein only for the purpose of emphasizing the utility of the terrestrial transmitting apparatus and method according to the invention. The satellite receiving antenna 16 is also not an element of the invention. Rather, the satellite receiving antenna 16 is discussed herein for the purpose of describing the manner and direction in which terrestrial signals must be transmitted according to the invention. In any case, the satellite and terrestrial receiving antennae which may be at any user location 14 need not be combined into a single structure. The combined structure 22 shown in FIG. 2 is shown for convenience in describing the terrestrial transmission invention disclosed herein.

In the case of an omni-directional satellite receiving antenna, the antenna has no centerline such as centerline 28 shown in FIGS. 1 and 2, and no look angle or directional reception range. Rather, the gain provided by the antenna is substantially independent of the direction from which the signals reach the antenna. In that case, the method of the invention includes transmitting terrestrial signals at the first frequency similarly to the case described above in which the satellite receiving antenna is a directional antenna. However, the direction at which the terrestrial signals are transmitted cannot be relied upon to produce terrestrial input signals below the interference level with respect to the satellite input signals received at the omni-directional satellite receiving antenna . Rather, for the omni-directional satellite receiving antenna, the terrestrial transmission power level is controlled so that the terrestrial signals present at the user location are below the interference level with respect to the satellite signals at the user location. Since the omni-directional antenna provides the same gain to both the terrestrial and satellite signals, this signal level present at the satellite receiving antenna location ensures that the terrestrial input signals are below the interference level with respect to the satellite input signals.

Referring to FIG. 3, a plurality of terrestrial transmitters 32 may be required to provide terrestrial signals strong enough to be received over a large area, but low enough to prevent interference with satellite signals at the same frequency. Each transmitter 32 in FIG. 3 transmits directionally in an azimuth range A of approximately 180 degrees and out to an effective reception range R. Thus, each transmitter 32 transmits to an effective transmission area 43. With this transmitter spacing and transmission range, the signals from the terrestrial transmitters 32 may be received from any location within the geographic service area comprising the combined effective transmission areas of the several terrestrial transmitters. Although the directional range of 180 degrees is shown for purposes of example, the terrestrial transmissions may be in other ranges within the scope of this invention. In each case, however, the terrestrial transmissions from each transmitter 32 are in directions that are outside of the satellite receiving antenna look angle at any location and, with the terrestrial signal power limitation according to the invention, the terrestrial signals do not interfere with the satellite signals transmitted at the same frequency.

In another aspect of the invention, the user location itself may include a transmitter for directionally transmitting at a satellite frequency. Such transmission capability from the user location would allow wireless communication both to and from the user location. The transmissions from the user location would be limited so as to include no direction within the look angle of a nearby satellite receiving antenna and would be limited as to transmission power as discussed above with regard to other terrestrial transmissions.

In the multiple terrestrial transmitter application of the invention such as the arrangement depicted in FIG. 3, it may be desirable, although not necessary, for the signals from the several transmitters 32 to be synchronized. The synchronization in this sense means that each transmitter transmits the same data at the same frequency so that it may be received substantially simultaneously at a user location which lies within the effective transmission area (the area defined by radius R) of two or more different transmitters. Thus, regardless of which transmitter 32 a user may direct their terrestrial receiving antenna to, the user receives the very same data as any other user of terrestrial signals at that frequency in the geographic service area. The transmitters may have associated with them signal synchronization means 44 for enabling this synchronized transmission. Those skilled in the art will appreciate that several different arrangements may be used to provide such synchronization. For example, the signal synchronization means 44 may comprise high speed communications links such as optical fiber or high speed electrical communications links for communicating data to be transmitted or synchronization signals between transmitters 32. Alternatively the synchronization means 44 may comprise high gain antennae for relaying the received signals from one transmitter 32 to the next. Any such relaying antennae and high speed communication links are to be considered equivalent signal synchronization means according to the invention.

As discussed above, and referring again to FIG. 1, the power level at which the terrestrial signals may be transmitted must be limited to prevent interference with the satellite signals transmitted at the same frequency. However, the transmission power must still be strong enough to produce a usable signal level at a distant location, location 14 for example. The power level of the terrestrially transmitted signals is highest near the transmitter and decreases as the distance from the transmitter increases. Thus, the transmission power is limited by the maximum terrestrial signal level at the potential satellite signal user location which is nearest to the terrestrial transmitter 20. The maximum terrestrial signal level at the nearest satellite user location to the terrestrial transmitter is a signal which produces a terrestrial input signal at a satellite receiving antenna at that nearest location which is just below the interference level with respect to the satellite input signals which may be received by the satellite receiving antenna at that location. The transmission power to produce signals of this strength at the nearest location to the terrestrial transmitter 20 represents the maximum allowable transmission power and determines the effective transmission range or area of the terrestrial transmitter. This maximum level and all transmission power levels below this maximum level are non-interfering power levels and produce non-interfering terrestrial input signals at any satellite receiving antenna in the effective transmission area of the terrestrial transmitter 20.

A certain area around the terrestrial transmitter may be designated an exclusion zone and the nearest location to the terrestrial transmitter may be defined as a location at the edge of the exclusion zone. In this case, the transmission power of the terrestrial transmitter is controlled so that the terrestrial signals are just below the interference power level at this "nearest location" at the edge of the exclusion zone. The terrestrial signal level at locations within the exclusion zone is at a level which could cause interference with satellite signals unless the satellite receiving antenna design is modified to increase the directionality of the antenna, that is, the difference between the gain provided to the satellite signals and the gain provided to the terrestrial signals.

It will be apparent that the maximum power level at which terrestrial signals may be transmitted in accordance with the invention is dependent in part upon the power level of the satellite signals at the various user locations. As shown in FIGS. 1 and 4, one preferred form of the invention includes a satellite signal power level monitoring arrangement or means 46 for determining the power level of the satellite signals and for using that power level to set the power level of the terrestrial transmitter 20. Referring now to FIG. 4, the satellite signal power level monitoring means 46 may comprise a calibrated receiver or any other suitable device by which the satellite signal strength may be determined. The illustrated calibrated receiver includes a satellite receiving antenna 48, a down-converter 50, preferably a channel selector 52, and a detector amplifier 54. The illustrated calibrated receiver also includes a comparator 56 with a variable resistance device 57 connected to one comparator input. The other comparator input is connected to receive the signal from the detector amplifier 54. Comparator 56 has its output connected transmission power adjusting means comprising to a level control device 58 associated with the terrestrial transmitter 20.

The illustrated transmitter 20 includes an encoder 60, which receives and encodes an input for terrestrial transmission, and also includes a modulator 62 for providing the desired modulation for transmission. The level control device 58 is interposed between the modulator 62 and an up-converter 63 which converts the signals to the desired higher frequency for transmission. The converted signals are then amplified by the power amplifier 64 and directed to a transmitter antenna 66.

The satellite power level monitoring arrangement 46 operates by continuously monitoring a satellite signal which, due to the particular satellite orientation and/or transmission power, is most susceptible to interference from the terrestrial transmitted signals. The satellite receiving antenna 48 is directed to receive the signal from that most susceptible satellite, and the received signal is down converted to an intermediate frequency by the down converter 50.

The down converted signal may be processed by the channel selector 52 to separate a single channel and this separated signal is then filtered and converted to a dc voltage signal by the detector amplifier 54. This dc voltage signal is representative of the power level of the received satellite signal, and is compared to a reference signal by the comparator 56. The reference signal is set by the variable resistance 57 initially so that the comparator output is zero. At this initial setting, the transmission power level of transmitter 20 is set at a maximum non-interfering power level. At this power level the terrestrial signals at the various locations beyond any exclusion zone around the transmitter 20 result in terrestrial input signals which are below the interfering power level with respect to any satellite input signals at the same frequency. However, as the signal power of the satellite signals received at the antenna 48 changes over time, the output of comparator 56 causes the level control 58 to change the transmission power of the terrestrial transmitter 20 accordingly. When the satellite signal becomes weaker than at initial conditions, the comparator 56 output is less than zero and this causes the level control 58 to reduce the transmission power from transmitter 20. When the satellite signal becomes stronger, the comparator 56 output returns toward zero and this causes the level control 58 to increase the transmission power to transmitter antenna 66.

The method of the invention may now be described with particular reference to FIGS. 1 and 2. A first frequency is already in use for transmitting satellite signals from a satellite, satellite 12*d* for example, along the satellite signal 42 route to location 14. Satellite signals are received at the location 14 with the satellite receiving antenna 16 shown in FIG. 2. Satellite receiving antenna 16 has a directional reception characteristic with a maximum gain along the antenna centerline 28 and lower gain at angles from the antenna centerline. The satellite receiving antenna 16 is oriented in a satellite reception position in which the satellite signal route 42 is within a look angle d max on either side of, or about, the centerline 28 of the antenna. In this satellite reception position, the satellite signals produce a satellite input signal from the satellite receiving antenna 16 and this input signal is at least at the minimum usable signal level for the particular signal processing equipment.

The method of the invention includes transmitting terrestrial signals at the first frequency, that is, the same frequency at which the satellite signals are transmitted. The terrestrial signals are transmitted in directions which include the wireless transmission route 40 from the transmitter 20 to the location 14. According to the invention, the transmitter 20 is located such that the wireless transmission route 40 lies at an angle to the satellite receiving antenna centerline 28, and this angle is sufficiently large that the terrestrial signals present at the location 14 produce terrestrial input signals which are below the interference level with respect to the satellite input signals produced at the antenna 16. The terrestrial signals present at the location 14 are also at a power level at least at the minimum usable terrestrial signal level. At this minimum useable terrestrial signal level the terrestrial signals may be picked up by a terrestrial antenna 18 which may be at the user location 14. The terrestrial antenna 18 is a directional antenna to ensure that the satellite signals do not interfere with the terrestrial signals.

Under current technology, the satellite signal level at any terrestrial user location may range from −120dBm to −125 dBm under clear sky conditions and from −122 dBm to −127 dBm under more adverse weather conditions. Depending primarily upon the directionality of the satellite receiving antenna and the capabilities of the signal processing equipment associated with the satellite receiving antenna, terrestrial signal power level at the user location must remain below about −95 dBm. This terrestrial signal power level assumes a satellite receiving antenna gain of approximately 34 dB for the satellite signals and a gain of about −2 dB for the terrestrial signals, and an interference level of approximately 4 dB below the satellite input signal power level. Also, under current technology, the terrestrial input signals must remain about 4.5 dB (3 dB to 5 dB) below the satellite input signals in order for the signal processing equipment to distinguish the satellite input signals and extract the desired data from the satellite input signals. Those skilled in the art will readily appreciate that the invention is not limited to these signal power values and that these values are provided for purposes of illustration and example.

Also according to the invention, the terrestrial transmitter 20 transmits only along wireless transmission paths which avoid interference with the satellite signals at any location within an effective transmission range of the terrestrial transmitter. That is, the wireless route 40 from the transmitter 20 to any location 14 is at an angle with respect to a properly aligned satellite receiving antenna at the respective location such that the terrestrial input signals from the satellite receiving antenna are always below the interference level with respect to the satellite input signals which may be produced from the satellite receiving antenna. To ensure the required terrestrial signal strength at any location, including those adjacent to the terrestrial transmission location, the method of the invention may also include monitoring the signal strength of the satellite signals and setting the terrestrial transmission power to the maximum non-interfering power level based upon that detected satellite signal strength.

Referring to FIG. 3, the method also includes transmitting from a second terrestrial transmitter 32 to a second location which may be any location within range R from the second terrestrial transmitter. The wireless route from the second transmitter to the second location is at an angle to a properly oriented satellite receiving antenna at the second location to produce terrestrial input signals below the interference level with respect to the satellite input signals which result from satellite signals received by the satellite receiving antenna at the second location.

EXAMPLE

A test was conducted using a mobile test antenna. The test equipment included a DBS receiving antenna connected to signal processing equipment. The signal processing equipment was connected to receive input signals from the DBS receiving antenna and operated to direct a desired channel output to a television. The DBS receiving antenna was a directional antenna providing a gain of between 31 dB and 34 dB across a look angle of approximately 5 degrees on either side of the antenna centerline. Antenna gain from the DBS receiving antenna ranged from −2 dB to −16 dB outside of the antenna look angle.

The test used a terrestrial transmitter having a directional transmitter antenna elevated to 52 feet AGL and directed with its peek power output at an azimuth of 180 degrees (due South), with true horizontal polarity. The terrestrial transmitter set up was not changed from this configuration throughout the test. Only the transmission power was varied as will be discussed below.

The interference test was conducted at several different test locations or user locations, each spaced apart from the terrestrial transmitter location. At each test location the DBS receiving antenna was first elevated to achieve a line of sight to the terrestrial transmitter and then oriented with its centerline aligned generally with the wireless transmission route from the terrestrial transmitter. Once a line of sight was verified between the DBS test antenna and the terrestrial transmitter, an isotropic receive power level was established from the terrestrial transmitter at full power, 29 dBm.

At each test location the DBS receiving antenna was then optimally positioned for receiving satellite signals from a particular DBS satellite, that is, the centerline of the DBS receiving antenna was aligned with the signal route from the satellite. The satellite signals at a particular frequency were received and fed to the television associated with the test apparatus. At each test site, the wireless transmission route from the terrestrial transmitter to the test site was outside of the look angle of the DBS receiving antenna optimally positioned for receiving satellite signals from the DBS satellite. The terrestrial transmitter was operated to transmit at the same frequency as the received satellite signals, 12.470 gigahertz. In each test if there was interference with the received DBS satellite signals, as indicated by imperfect television reception, the terrestrial transmitter power was reduced until no interference was produced and this level, that is, the power level just below the interference level, was recorded.

At the weather conditions at which the tests were conducted, the satellite signal power level at each test site is calculated to be approximately −125 dBm. Under these conditions a terrestrial transmission power level of 13 dBm produced an exclusion zone in the transmission directions around the terrestrial transmitter of approximately one quarter mile while producing useable terrestrial signals at a location approximately 9.9 miles away from the terrestrial transmitting antenna. It is estimated that the terrestrial signal power level at this test site was approximately −137 dBm.

The above described preferred embodiments are intended to illustrate the principles of the invention, but not to limit the scope of the invention. Various other embodiments and modifications to these preferred embodiments may be made by those skilled in the art without departing from the scope of the following claims.

What is claimed is:

real time control

1. A method for reusing a first transmission frequency already in use for transmitting satellite signals from a satellite along a satellite signal route to a first location for reception at a satellite receiving antenna which may be at the first location, the satellite receiving antenna producing a maximum gain for signals received along a satellite receiving antenna centerline and less gain at angles from said centerline, the satellite signals having a signal power level at the first location such that, when the satellite receiving antenna is placed in a satellite reception position in which the satellite transmission route lies within a satellite reception look angle about the satellite receiving antenna centerline, the satellite signals produce satellite input signals from the satellite receiving antenna which are at least at a minimum usable satellite input signal level, the method comprising the steps of:

(a) substantially continuously detecting the satellite signal power level at a location near a first terrestrial transmitter;

(b) setting the transmission power of the first terrestrial transmitter to a non-interfering level based upon the satellite signal power level detected near the first terrestrial transmitter, the non-interfering level being a level ensuring that substantially each location within an effective transmission area around the first terrestrial transmitter receives terrestrial signals from the first terrestrial transmitter at a power level to produce non-interfering terrestrial input signals from a satellite receiving antenna aligned to receive satellite signals at said location, the non-interfering terrestrial input signals being at a power level less than an interference level with respect to the satellite input signals produced by the satellite receiving antenna at said location; and

(c) transmitting terrestrial signals at the first transmission frequency from the first terrestrial transmitter, the terrestrial signals being transmitted in directions including a wireless transmission route from the first terrestrial transmitter to the first location, and the wireless transmission route lying at an angle from the satellite receiving antenna centerline, when the satellite receiving antenna is in the satellite reception position, such that the terrestrial signals present at the first location result in terrestrial input signals from the satellite receiving antenna which are at a power level less than the interference power level with respect to the satellite input signals, the terrestrial signals present at the first location having a power level at least at a minimum usable terrestrial signal level.

2. The method of claim 1 wherein the step of detecting the satellite signal power level includes the steps of:

(a) receiving the signals transmitted from the satellite at the first transmission frequency; and

(b) converting the signals transmitted from the satellite at the first transmission frequency to a representative signal which is representative of the satellite signal power level.

3. The method of claim 2 wherein the step of setting the transmission power level for the first terrestrial transmitter includes the step of:

(a) comparing the representative signal to a reference signal to produce a comparison output.

4. The method of claim 3 further including the step of:

(a) using the comparison output to control the transmission power level for the first terrestrial transmitter.

5. The method of claim 4 wherein the step of using the comparison output to control the transmission power level for the first terrestrial transmitter includes the step of:

(a) controlling a modulated signal level in the first terrestrial transmitter.

6. An apparatus for simultaneously providing terrestrially transmitted signals on a common frequency with satellite signals transmitted from a satellite along a satellite signal route to a first location, the satellite signals being transmitted at a first frequency for reception at a satellite receiving antenna which may be at the first location, the satellite receiving antenna producing a maximum gain for signals received along a satellite receiving antenna centerline and less gain at angles to said centerline, the satellite signals having a signal power level such that, when the satellite receiving antenna is placed in a satellite reception position in which the satellite transmission route lies within a satellite reception look angle about the satellite receiving antenna centerline, the satellite signals result in satellite input signals from the satellite receiving antenna which are at least at a minimum usable satellite input signal level, the apparatus comprising:

(a) a first terrestrial transmitter for transmitting signals at the first frequency along a wireless transmission route from a first terrestrial transmitter location to the first location, the wireless transmission route lying at an angle from the satellite receiving antenna centerline, when the satellite receiving antenna is in the satellite reception position, such that the terrestrial signals present at the first location result in terrestrial input signals from the satellite receiving antenna which are at a power level less than an interference level with respect to the satellite input signals, the terrestrial signals present at the first location having a power level at least at a minimum usable terrestrial signal level;

(b) satellite signal power monitoring means for substantially continuously detecting the satellite signal power level at a location near the first terrestrial transmitter; and

(c) transmission power adjusting means associated with the first terrestrial transmitter for setting the transmission power of the first terrestrial transmitter to a non-interfering level based upon the satellite signal power level detected by the satellite signal power monitoring means, the non-interfering level being a level ensuring that substantially each location within an effective transmission area around the first terrestrial transmitter receives terrestrial signals from the first terrestrial transmitter at a power level to produce non-interfering terrestrial input signals from a satellite receiving antenna aligned to receive satellite signals at said location, the non-interfering terrestrial input signals being at a power level less than the interference level with respect to the satellite input signals produced by the satellite receiving antenna at said location.

7. The apparatus of claim 6 wherein the satellite signal power monitoring means includes:

(a) a satellite signal receiving antenna aligned to receive signals transmitted from the satellite at the first transmission frequency; and

(b) a detector amplifier operatively connected to convert the signals received by the satellite signal receiving antenna to a representative signal which is representative of the satellite signal power level.

8. The apparatus of claim 7 wherein the satellite signal power monitoring means further includes:

(a) a comparator operatively connected to compare the representative signal to a reference signal to produce a comparison output.

9. The apparatus of claim 8 wherein the transmission power adjusting means includes a level control device operatively connected to the first terrestrial transmitter and wherein the comparator is connected to apply the comparison output to the level control device.

10. The apparatus of claim 9 wherein the level control device is operatively connected to an output of a modulator associated with the first terrestrial transmitter, the level control device for controlling a modulated signal level in the first terrestrial transmitter.

11. An apparatus for simultaneously providing terrestrially transmitted signals on a common frequency with satellite signals transmitted from a satellite, the satellite signals being transmitted at a first frequency along a satellite transmission route to a satellite receiving antenna at a location which may be anywhere within a geographic service area, the satellite receiving antenna producing a maximum gain for signals received along a satellite receiving antenna centerline and less gain at angles from said centerline, the satellite signals having a signal power level which, when the satellite receiving antenna is placed at a satellite reception position in which the satellite transmission route lies within a satellite reception look angle about the satellite receiving antenna centerline, results in satellite input signals from the satellite receiving antenna, the satellite input signals being at least at a minimum usable satellite input signal level, the apparatus comprising:

(a) a plurality of spaced apart terrestrial transmitters, each terrestrial transmitter transmitting terrestrial signals at the first frequency, the plurality of spaced apart terrestrial transmitters being arranged such that substantially each respective location within the geographic service area has a wireless transmission route to one of the terrestrial transmitters, the wireless transmission route lying at an angle from the satellite receiving antenna centerline when the satellite receiving antenna is in the satellite reception position at the respective location such that the terrestrial signals present at the respective location are at least at a minimum usable terrestrial signal level but result in terrestrial input signals from the satellite receiving antenna which are at a power level less than an interference level with respect to the satellite input signals;

(b) satellite signal power monitoring means for substantially continuously detecting the satellite signal power level at a monitoring location within the geographic service area; and

(c) transmission power adjusting means associated with the terrestrial transmitters for setting the transmission power of the terrestrial transmitters to a non-interfering level based upon the satellite signal power level detected by the satellite signal power monitoring means, the non-interfering level being a level ensuring that substantially each location within the geographic service area receives terrestrial signals from each of the terrestrial transmitters at a power level to result in non-interfering terrestrial input signals from a satellite receiving antenna aligned to receive satellite signals at said location, the noninterfering terrestrial input signals being at a power level less than the interference level with respect to the satellite input signals produced by the satellite receiving antenna at said location.

12. The apparatus of claim 11 wherein the satellite signal power monitoring means includes:

(a) a satellite signal receiving antenna aligned to receive signals transmitted from the satellite at the first transmission frequency; and

(b) a detector amplifier operatively connected to convert the signals received by the satellite signal receiving antenna to a representative signal which is representative of the satellite signal power level.

13. The apparatus of claim 12 wherein the satellite signal power monitoring means further includes:

(a) a comparator operatively connected to compare the representative signal to a reference signal to produce a comparison output.

14. The apparatus of claim 13 wherein the transmission power adjusting means includes a level control device operatively connected to the first terrestrial transmitter and wherein the comparator is connected to apply the comparison output to the level control device.

15. The apparatus of claim 14 wherein the level control device is operatively connected to an output of a modulator associated with the first terrestrial transmitter, the level control device for controlling a modulated signal level in the first terrestrial transmitter.

16. A method for reusing a first transmission frequency already in use for transmitting satellite signals from a satellite along a satellite signal route to a first location for reception at a satellite receiving antenna which may be at the first location, the satellite receiving antenna producing a maximum gain for signals received along a satellite receiving antenna centerline and less gain at angles from said centerline, the satellite signals having a signal power level at the first location such that, when the satellite receiving antenna is placed in a satellite reception position in which the satellite transmission route lies within a satellite reception look angle about the satellite receiving antenna centerline, the satellite signals produce satellite input signals from the satellite receiving antenna which are at least at a minimum usable satellite input signal level, the method comprising the steps of:

(a) determining the satellite signal power level;

(b) setting the transmission power of a first terrestrial transmitter to a non-interfering level based upon the determined satellite signal power level, the non-interfering level being a level ensuring that substantially each location within an effective transmission area around the first terrestrial transmitter receives terrestrial signals from the first terrestrial transmitter at a power level to produce non-interfering terrestrial input signals from a satellite receiving antenna aligned to receive the satellite signals at said location, the non-interfering terrestrial input signals being at a power level less than an interference level with respect to the satellite input signals produced by the satellite receiving antenna at said location; and

(c) transmitting terrestrial signals at the non-interfering power level and first transmission frequency from the first terrestrial transmitter to the effective transmission area.

non-real time
power control

17. The method of claim 16 wherein the step of determining the satellite signal power level includes the steps of:

(a) receiving the signal transmitted from the satellite at the first transmission frequency; and

(b) converting the signal transmitted from the satellite at the first transmission frequency to a representative signal which is representative of the satellite signal power level.

18. The method of claim 17 wherein the step of setting the transmission power level for the first terrestrial transmitter includes the step of:

(a) comparing the representative signal to a reference signal to produce a comparison output.

19. The method of claim 18 further including the step of:

(a) using the comparison output to control the transmission power level for the first terrestrial transmitter.

20. The method of claim 19 wherein the step of using the comparison output to control the transmission power level for the first terrestrial transmitter includes the step of:

(a) controlling a modulated signal level in the first terrestrial transmitter.

* * * * *

JUST ONE STEP NEEDED
See - Claim # 1

US006169878B1

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Tawil et al.

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(54) **APPARATUS AND METHOD FOR TRANSMITTING TERRESTRIAL SIGNALS ON A COMMON FREQUENCY WITH SATELLITE TRANSMISSIONS**

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(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

This patent is subject to a terminal disclaimer.

1997

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Related U.S. Application Data

(63) Continuation of application No. 08/731,244, filed on Oct. 11, 1996, now Pat. No. 5,761,605.

(51) **Int. Cl.**[7] **H04H 1/00**; H04B 7/185

(52) **U.S. Cl.** **455/3.2**; 455/13.3

(58) **Field of Search** .... 455/3.2, 13.3, 455/427, 430, 12.1, 63, 272, 188.1, 179.1, 561, 562; 348/6, 12, 13; 343/878–879, 725, 893, DIG. 2; 705

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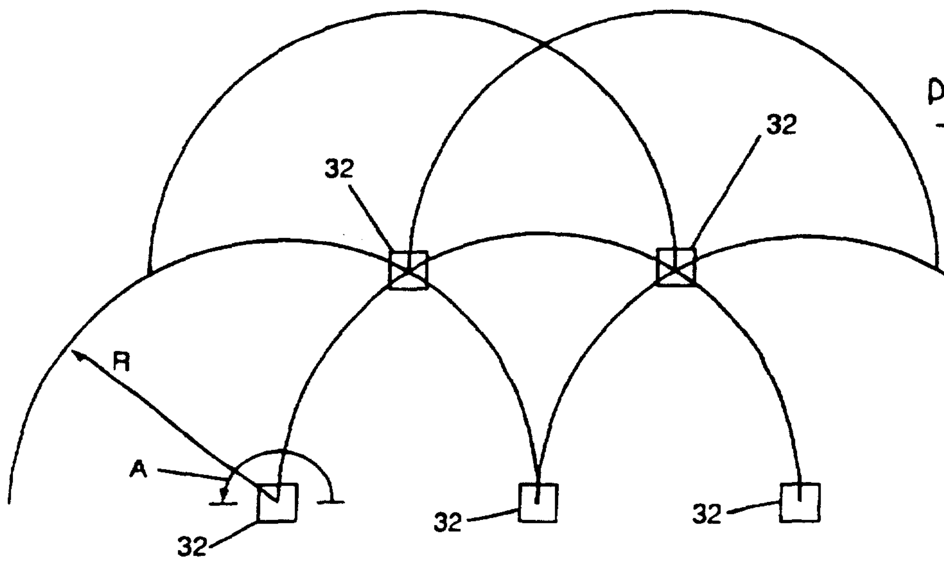
(57) **ABSTRACT**

A first antenna (**16**) at a user location (**14**) receives signals at a first frequency where the signals are travelling only within a first directional reception range as measured from a centerline (**28**) of the first antenna (**16**). The first antenna (**16**) has its centerline (**28**) aligned to receive direct broadcast satellite signals transmitted from a satellite in geosynchronous orbit about the earth. A second antenna (**18**) at the user location (**14**) receives signals at the first frequency where the signals are travelling only within a second directional reception range as measured from a centerline (**30**) of the second antenna (**18**). The second antenna (**18**) is aligned to receive signals transmitted at the first frequency from a terrestrial transmitting location remote from the user location. A terrestrial transmitter transmits signals at the first frequency and directionally within a terrestrial azimuth range from the terrestrial transmitting location. The terrestrial transmitting location is located with respect to the user location (**14**) such that the terrestrial transmitter (**20**) transmits in directions only outside of the directional reception range of the first antenna (**16**). The satellite (**12**) is positioned with respect to the user location (**14**) such that the satellite transmits directional in directions outside of the directional reception range of the second antenna (**18**).

DIRECTIONAL TRANSMISSION

23 Claims, 2 Drawing Sheets



Directional Transmission Network

See Column #6 for claims

Figure 1

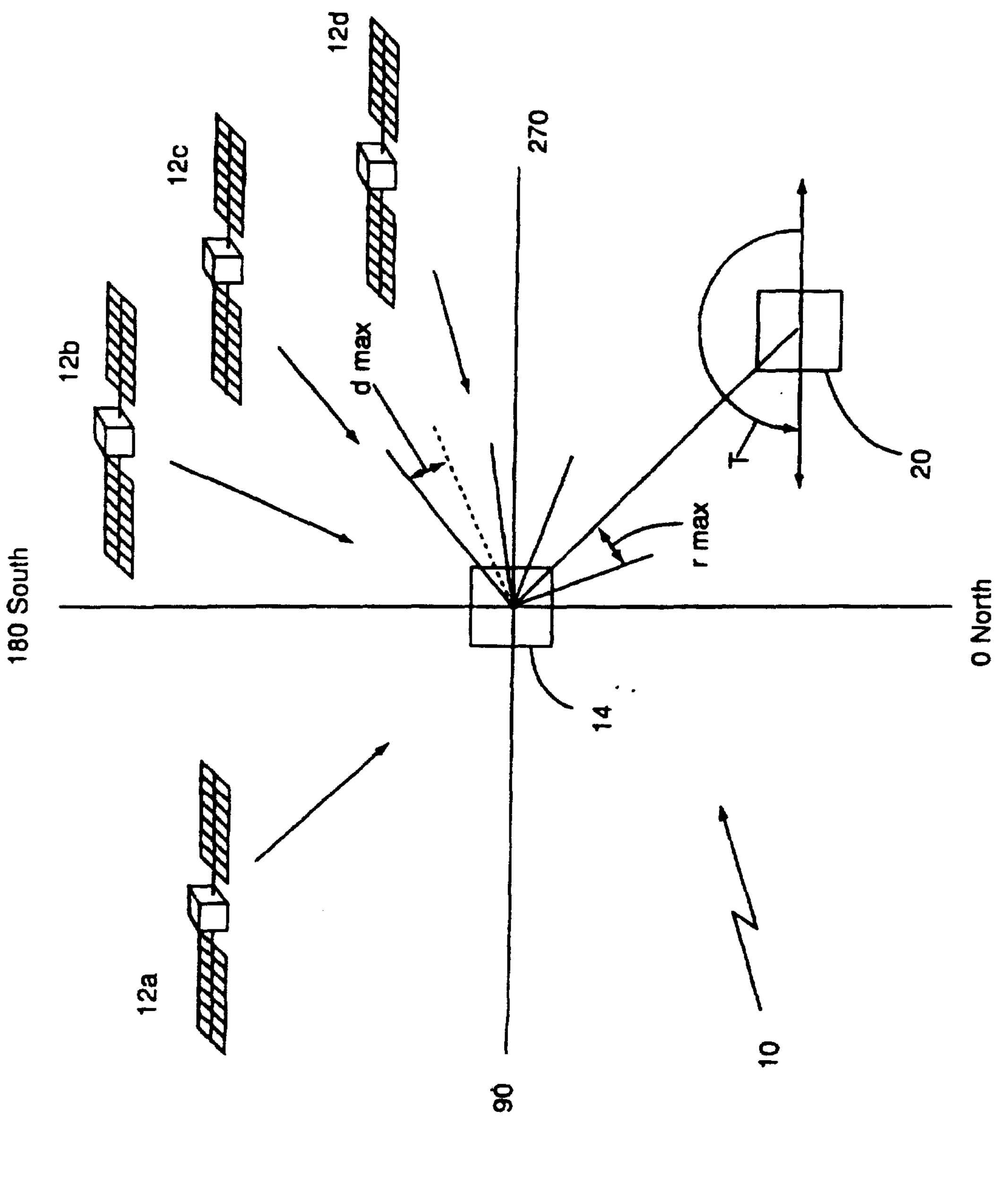


Figure 2

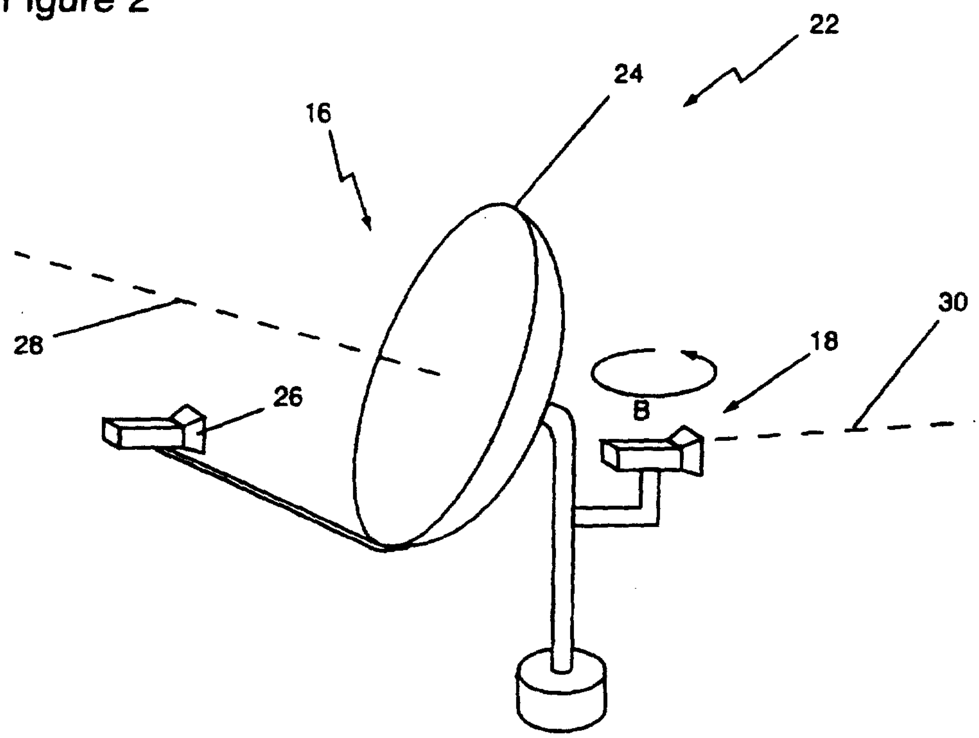


Figure 3